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Book Reviews

Numerical Methods for Engineers and Scientists, 2nd Edition

J. D. Hoffman, Marcel Dekker, Inc., New York, 2001, 823 pp., $95.00

This is the second, revised and expanded, edition of Joe Hoffman's well-known book on numerical methods. It is similar to, yet different from, the first edition. There are 13 chapters organized in three parts. The first six chapters constitute Part I, entitled "Basic Tools of Numerical Analysis," and discuss systems of linear algebraic equations, eigenproblems, nonlinear equations, polynomial approximation and interpolation, numerical differentiation and difference formulas, and numerical integration. Part II, "Ordinary Differential Equations," has two chapters on one-dimensional ordinary differential equations for initial-value and boundary-value problems, respectively. Finally, the four chapters of Part III, "Partial Differential Equations," provide introductions to numerical methods for elliptic, parabolic, and hyperbolic partial differential equations, respectively, and, finally, to the finite element method. These 12 technical chapters are preceded by Chapter 0, "Introduction."

Chapter 0 is a bit of a grab bag. It begins with the obligatory synopsis on the objective and structure of the book. This is followed by an abrupt and brief discussion of significant digits, precision, accuracy, errors, and number representation. This discussion is long on definitions and short on examples, and it may strike the reader as somewhat disjointed from the rest of the text, at least in the first pass through this book. While one might be still pondering this oddity, gears are switched again, and the reader is exposed to a cursory discussion of commercial software packages such as Macsyma, Mathcad, and the like. This is followed by presentations on standard libraries such as IMSL and LAPACK that read a little bit like product descriptions from software shipping boxes. Then, bearing with the author through one short paragraph on the Numerical Recipes book (it's a bit unclear why it is mentioned there), and through a tabulation of Taylor and MacLaurin series, and, finally, the journey through the 12 technical chapters begins.

As an undergraduate student, one of my gripes with professors and books was that they helped me but little to overcome my problem of not seeing the forest for the trees. Professor Hoffman promises to first introduce a type of problem and to "present sufficient background to understand the problem and possible methods of solution." I was hoping to maybe see a wheel/suspension/car problem presented to discuss eigenproblems, or to see shock tubes discussed as a way to provide high-Mach-number experimental facilities that can be estimated using one-dimensional hyperbolic systems. Having set the stage that way, I guess I expected to see the governing equations being developed along with solution paths. Professor Hoffman has obviously a different view on the introduction of a mathematical problem and presentation of its solution methods. There is, for instance, a cartoon of a generic mass-spring setup to introduce eigenproblems, and an equally generic beam bending sketch, along with a reference to Timoshenko's 1955 book, is used to illustrate a higher-order boundary-value ordinary differential equation problem. I was obviously left unimpressed, but then again, it could be just false expectations on my part and my misunderstanding of Prof. Hoffman's introduction.

Professor Hoffman demonstrates a solid knowledge of the nuts and bolts of basic numerical methods. On occasion, students are exposed to several alternate methods to solve a particular problem. The pros and cons are discussed, and a preferred approach crystallizes. For instance, it is demonstrated how the ringing in direct polynomial curve fits can be overcome with least-square fits. In another example, for several finite-difference approximations to partial differential equations, the tried-and-true von Neumann stability analysis is used to explain that certain time-space differencing concepts are just a bad idea.

For undergraduate students, that might be just the fare they are looking for: a basic, limited, yet thorough (sometimes a bit too thorough for my taste) introduction to numerical techniques. For more distinguishing palates, this book might be a touch too light, particularly in the area of computational fluid dynamics (CFD). Graduate students or aerospace practitioners might be more interested in an introductory text that sets the stage for self-study using seminal technical reports. Yet there are just two pages of references, by far too limited to guide the reader to advanced study.

The latter is symptomatic of the strengths and weaknesses of this book. The first two chapters are the book's strongest points, and the third chapter on partial differential methods is its weakest. There is no mention of state-of-the-art techniques such as multigrid convergence acceleration and unstructured grid methods. Milestones in the development of CFD such as the upwind schemes by Osher, Roe, or van Leer are nowhere to be found.

In summary, if you are looking for a good, solid instructional text on the basic tools of numerical analysis *sans* anything related to modern CFD, this book might be for you. If you are looking for an alternate didactic approach to teach the basics of CFD from a historic vantage point, different from that, say, in Patrick Roache's classic text, then this book might still be for you. If you are looking for an introduction to present-day CFD practices, you might want to keep searching.

Peter Hartwich
The Boeing Company

Low-Speed Aerodynamics, 2nd Edition

Joseph Katz and Allen Plotkin, Cambridge University Press, New York, 2001, 632 pp., $35.95

The second edition of *Low-Speed Aerodynamics* has expanded the scope of the original text, which was primarily focused on the development of potential flow theory and its application to a variety of problems. Viscous flow theory is presented with emphasis on the classical laminar boundary-layer solutions. Transition and turbulent boundary-layer theory are acknowledged but not discussed in detail. The intent is to demonstrate the ability to couple potential flow solution techniques with viscous flow solutions for thin nonseparating boundary layers to obtain realistic predictions of aerodynamic performance.

Katz and Plotkin begin with the development of the fundamentals of incompressible potential flow and its application to thin airfoil theory and lifting line theory. This evolves naturally into higher-order methods including matched asymptotic expansions and slender wing and body theory. It is refreshing to see the complex potential introduced for the study of exact solutions in two-dimensional flow. However, it is disappointing that the inverse (design) problem is not covered, because this is a natural application of the complex variable approach.

The true merit of this text lies in its extensive development and presentation of numerical methods for potential flow solutions, particularly panel methods. These are built from the fundamentals described in the early chapters, and the book offers the reader a comprehensive presentation under a single cover. Several methods for both two- and three-dimensional flow computations are presented, along with their features and shortcomings. In addition to being a textbook, this book would be an excellent reference for the practicing aerodynamicist.

Discussion of viscous flow is somewhat shallow, but at the same time too much attention is devoted to some of the classical laminar-boundary-layer-solution techniques. The intent appears to be to acquaint the reader with the process of coupling potential flow solutions with boundary-layer solutions, and this could be done with a more balanced emphasis on turbulent and laminar boundary layers. The final chapter is more effective in presenting real flow effects.

In summary, the title itself, *Low-Speed Aerodynamics*, leaves open a long list of classical theory and methodology that could be cited as a critical omission. Examples include the contributions of Lighthill, Theodorsen, Squire and Young, Truckenbrodt, Smith, Thwaites, and Jones. Conversely, the value of the Katz and Plotkin book lies in its unified presentation of classical and modern numerical techniques for the calculation of potential flow about aerodynamic bodies of arbitrary geometry. This book is indeed a worthwhile contribution to our literature.

R. H. Liebeck
The Boeing Company